

## **Attachment B**

# PERMITTING UNLICENSED DEVICES ON BROADCAST SPECTRUM DURING THE DTV TRANSITION: SUBSTANTIAL COSTS AND RISKS, LARGELY SPECULATIVE BENEFITS

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## I. INTRODUCTION

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The Association for Maximum Service Television, Inc. (“MSTV”) and the National Association of Broadcasters (“NAB”) have asked us to comment on various economic aspects of the Commission’s *Notice of Inquiry* (“*NOR*”) addressing the possibility of permitting unlicensed devices to operate in additional frequency bands.<sup>2</sup> In particular, they have asked us to assess the likelihood that expected benefits of permitting the use of such devices in the *television* broadcast spectrum *at this time* exceed any reasonably anticipated adverse consequences.

The Commission (§1) avers that permitting use of unlicensed devices “could have significant benefits to the economy, businesses and consumers by allowing the development of new and innovative types of unlicensed devices.” It is hard to disagree that benefits *could*—i.e., might possibly or conceivably—be significant. While the similarly conceivable possibility remains unremarked by the Commission, they *could* also be *insignificant* (or *negative* if there were sufficiently adverse consequences as well). The issue in either case is whether it is reasonable to anticipate that the *net* of any beneficial and adverse consequences of authorizing use of unlicensed devices is non-negative and greater than any associated costs.

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<sup>2</sup> See *In the Matter of Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3GHz Band*, ET Docket No. 02-380, released: December 20, 2002.

In this paper, we explain the economic bases for our conclusion that the Commission has (1) not established that the upsides from proceeding in the proposed fashion are substantial, and (2) not adequately considered the downsides, which appear substantial. We explain why the proposed policy poses substantial risks to the transition to digital broadcast television and the benefits associated with achievement of the public policy objectives attached thereto (including subsequent other uses of the spectrum).

The purported upsides of allowing unlicensed devices into the television broadcast band during the DTV transition are largely speculative. For reasons stated herein, we do not believe the potential benefits justify the risks to consumer welfare. This is particularly true because the contemplated unlicensed use of broadcast spectrum entails significant opportunity costs in terms of alternative uses of the broadcast spectrum, not only during but also after the digital transition.

Our presentation is organized in the following manner: We begin with a general examination of the costs, risks and benefits of permitting unlicensed use during the DTV transition. We then turn to consideration of the special issues posed by the ongoing transition to digital broadcasting, a complex process with significant implications not only for the future of broadcast television, but also for the efficient management of spectrum resources. Next, we evaluate the benefits of permitting unlicensed use of the television spectrum. We focus throughout on the economic tradeoffs that are posed by the Commission's proposed policies and the most plausible optimization of those tradeoffs for economically efficient outcomes. Finally, we consider the implications of unlicensed use of broadcast spectrum for maximization of future spectrum values. Here the tradeoffs are between higher values later and the benefits potentially derived from use of unlicensed devices in the near term.

In each of these three areas, our analysis suggests that authorizing use of unlicensed devices involves substantial risks and costs, and the benefits are largely speculative. Our conclusion is thus that a decision to authorize use of unlicensed devices in the television broadcast spectrum at this time would be uneconomic and constitute an inefficient allocation of scarce spectrum resource rights.

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## II. THE COSTS AND RISKS OF PERMITTING UNLICENSED USE OF THE TELEVISION SPECTRUM DURING THE DTV TRANSITION

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### A. TELEVISION BROADCASTING IS A HIGH-VALUE SPECTRUM USE.

In economic terms, television broadcasting ranks among the highest-value spectrum utilizations. The following analysis initially focuses on the current value of off-air television services. We would observe, however, that the “value added” services enabled by DTV could substantially improve consumer welfare beyond its current level. These services include multi-casting, HDTV and possible ancillary services. As we discuss below, it is quite possible that the value of these services may not be realized fully if unlicensed devices are permitted to occupy television broadcast channels during the transition.

By focusing initially on the current value provided by basic free over the air television service, we provide a very conservative estimate of the value of using spectrum for broadcast services. Even that conservative estimate is enormous. More than 98 percent of total households have television sets. Different members of the average TV household collectively spend almost 8 hours per day viewing.<sup>3</sup>

There are over 267 million television sets in American homes today. Nearly one third of all these television sets (81 million) rely exclusively on free over-the-air television for programming and are not connected to any other subscription service. Of this amount approximately 46.5 million television sets are in “broadcast-only” homes and 34 million television sets are found in homes with access to a multichannel video provider, but nonetheless remain unconnected to the service.<sup>4</sup>

It is important to note, as the Commission has itself often recognized, that economic measures of the commercial value of broadcasting (e.g., the revenues broadcasters derive from sales of commercial audience exposures to advertisers or the market exchange value of individual station properties primarily reflecting anticipated net income from such sales in the future) greatly understate the *true* economic value of broadcasting. That is because broadcast television is primarily supported through commercial advertising. In economic terms, programming is thus a

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<sup>3</sup> See Television Bureau of Advertising, [www.tvb.org/rcentral/index.html](http://www.tvb.org/rcentral/index.html).

<sup>4</sup> *Second Report and Order and Second Memorandum Opinion and Order, Review of the Commissions Rules and Policies Affecting the Conversion to Digital Television*, MM Docket No. 00-39 (released August 9, 2002) at ¶33.

kind of “factor payment” offered to viewers who, in return, literally “pay” attention that is then packaged in the form of commercial minutes (embodying audience exposures of varying quality and quantity) for sale to advertisers.

“Audience exposures” (reflecting commercial message delivery to different demographic populations) constitute the exchange commodity that is the subject of commercial transactions in the economic marketplace. The *realized* economic monetary value of spectrum resource rights in this activity is thus primarily derived from the demand by advertisers for commercial audience exposures, *rather than the economic value that viewers place on programming*, which (in the case of free, over-the-air television) is not translated into a monetary demand and thus not directly measurable.<sup>5</sup> The measured value of broadcast programming in the “marketplace” reflects the derived demand for advertising exposures (*i.e.*, the expected value of the marginal productivity of advertising to advertisers) rather than the consumer demand for broadcast programming (*i.e.*, the value of the marginal utility of broadcast programs to consumers).<sup>6</sup>

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<sup>5</sup> One of us (Haring) participated as a graduate research fellow at Yale University in the first academic effort to estimate quantitatively the economic value of free, over-the-air broadcasting *to consumers* (as opposed to advertisers). See Peck, McGowan & Noll, *Economic Aspects of Broadcast Regulation* (The Brookings Institution, Washington, D.C., 1973), Appendix A. See also Owen & Wildman, *Video Economics* (Harvard, 1992); and Setzer & Levy, “Broadcast Television in a Multichannel Marketplace,” FCC Office of Plans & Policy Working Paper Series No. 26, Washington, D.C., June 1991.

<sup>6</sup> An alternative way of viewing the matter is to remark how comparatively crude “viewing” is as an economic valuation measure for broadcast programming. While the presence or absence of “eyeballs” may be a reasonably good measure of advertising productivity (especially when the specific demographic makeup of an audience can be estimated), it provides only a very rough approximation of consumer valuation and presumes that audience size is proportionate to economic valuation (which is not to suggest that there is no connection between number of viewers and value derived). Cf. One program might be greatly preferred to another, but if they attract comparably sized audiences, on this criterion they are assumed to be approximately equally highly valued by consumers. Accurately inferring the effects of greater signal interference on consumer welfare by assessing effects on viewership is not only likely to be impossible, but also even if feasible would provide only a very crude gauge of effects on economic welfare. We observe that economic studies of the demand for multichannel video program distribution typically identify reception quality as an important (monetary) demand driver for MVPD subscriptions, accounting for a significant part of the economic benefits consumers derive from cable and satellite services. This implies that, were it possible to attach a monetary value to the economic loss associated with *less* “interference-free” broadcast signal reception, it would be substantial. See, e.g., Noll, Peck & McGowan, *op. cit.* As we presently discuss, the incapacity for such valuations to be manifested in market valuations of different spectrum operating rights implies that there will be a tendency toward allowance of “too much” interference. In particular, were such valuations reflected in bargaining negotiations, the value of “clearer” reception would presumably be greater and, in consequence, fewer rights would be utilized for interfering usage.

As is frequently noted in the relevant economics professional literature, “consumers value programming more than advertisers value audience exposures.”<sup>7</sup> While quite substantial in its own right, the usual “market” valuation of spectrum (reflected in broadcast stations’ national and local advertising sales revenues and/or the exchange value of station properties reflecting expected income from such sales in the future) will thus be substantially less than its true economic value, which also reflects (indeed, consists *primarily* of) the value consumers place on the programming that is delivered using broadcast spectrum inputs.<sup>8</sup>

*Ceteris paribus*, pure market valuation would thus tend to “under-allocate” spectrum to this activity under this type of market organization (*viz.*, commercially supported broadcasting). This is because the value consumers place on additional programming is much greater than the value advertisers place on an additional audience exposure. Stated alternatively, there are *very large* economic externalities associated with the purchase and sale of broadcast audience exposures in the “commercial” marketplace: In particular, programming that is very highly valued by consumers is produced *as a byproduct* of the trade in commercial minutes—a real-world case of the tail wagging the dog!<sup>9</sup>

As has been famously elucidated by Economic Nobelist Paul Samuelson,<sup>10</sup> among others, broadcast programming has the character of a “public good” in economic terms: the marginal cost of its being viewed by an additional viewer is virtually zero.<sup>11</sup> One of the primary advantages of free over-the-air broadcasting is that the consumer benefits of broadcast

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<sup>7</sup> See Owen & Wildman, *op. cit.*

<sup>8</sup> In 2000, broadcast TV ad revenues (excluding network ad and syndication revenues) were nearly \$45 billion (See Television Bureau of Advertising, *Trends in GDP/Total Ad Volume/TV Ad Volume, Trends in Advertising Volume*, [www.tvb.org/tvfacts/trends](http://www.tvb.org/tvfacts/trends). In 1973 Professors Peck, McGowan and Noll estimated the consumer surplus viewers derive from free, over-the-air television broadcasting to be approximately equivalent to more than 5 percent of their income (See *op. cit.*)—a value *greatly* in excess of \$45 billion given that national income currently exceeds \$8 trillion.

<sup>9</sup> One proxy measure for the value of this “programming byproduct,” would be to examine the additional costs consumers may have to pay in order to replicate such programs in the absence of free over-the-air TV. At least one industry analyst estimates that in the absence of free over-the-air television, cable systems would have to pay an additional \$38.9 billion to replicate this service, amounting to \$34.00 per sub per month. Victor Miller, Bear Stearns, Television Industry Summit: Cost of the Demise of “Free-Over-the-Air” TV Model, November 26, 2002 at 16.

<sup>10</sup> See “The Pure Theory of Public Expenditure,” *Review of Economics and Statistics*, Vol. 36 (November 1954).

<sup>11</sup> While perhaps related to legal “public interest” arguments, please note that we are using the term “public good” in the technical *economic* sense of a good characterized by “non-rivalry” in consumption (my watching the program does not leave less for you to watch) and “non-exclusion” (the marginal cost of an additional consumer watching a program is virtually zero). Economic theory suggests a general tendency toward under-provision of public goods relative to efficient levels in the absence of effective action by a relevant “collectivity” of some sort.

programming (*i.e.*, the “consumer surplus” or “consumer welfare” in economic terminology) are maximized as a consequence of the fact that the “price” is (virtually) zero. Any non-zero price would exclude some viewers and entail the sacrifice of some consumer benefits—benefits that carry no costs to produce, given the “public good” character of broadcasting.

Broadcasting is thus a high-value activity, but only a minority of the economic benefits it produces is accurately reflected in measured market economic exchange valuations (*viz.*, advertising sales and station property values). The *magnitude* and *special character* of the economic benefits that broadcasting produces have two important implications for the issues posed in this proceeding: (1) The “public good” character of broadcast programming implies that large consumer valuations of programming will not be effectively represented in the allocation of scarce operating rights, with the result that there will be “too much” interfering usage from the standpoint of economic efficiency; and (2) The large magnitude implies that even relatively small service degradations can carry very large adverse consequences (small losses suffered by many may equal substantial losses in aggregate).

We next consider each of these important economic implications of broadcasting’s high value and “public-good” character more thoroughly.

**B. THE TRUE VALUE OF BROADCASTING TO THE PUBLIC  
WILL NOT BE ADEQUATELY REFLECTED IN EFFORTS TO  
PROTECT BROADCASTING FROM INTERFERENCE FROM  
UNLICENSED DEVICES.**

Suppose, as contemplated in the FCC Spectrum Task Force’s *Report*,<sup>12</sup> spectrum resource rights were ubiquitously (although perhaps not uniformly) redefined in terms of “interference temperatures” (*i.e.*, in terms of various dimensions of spectrum “outputs” instead of or in addition to various “inputs” as is largely the current practice) and, furthermore, that resource rights so defined could be traded in a market.<sup>13</sup> Let us, for purposes of argument, leave aside issues associated with the transactions costs that may or may not attend operation of such a market.

As Economic Nobelist Ronald Coase notes in his widely cited article, “The Problem of Social Cost,”<sup>14</sup> in a world of zero transactions costs, *for efficiency* it matters not (or less) *how* resource

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<sup>12</sup> *See op. cit.*

<sup>13</sup> It is worth noting that, in the present situation, the “interference rights” have not been defined. To date, the FCC has no appropriate “real world” metric for accurately assessing the “interference temperature.”

<sup>14</sup> *Journal of Law and Economics* (October 1960).

operating rights are defined, but (or than) *that* they are defined.<sup>15</sup> In the instant context, the Coasian argument would be that (assuming zero transactions costs) if newcomers were afforded the right to undertake activities that interfere (to some extent) with broadcasting, broadcasters could successfully induce them to desist by paying them to forego such activities were the value of the harms greater than the value of the benefits of such activities. If the value of the perceived harms were less than the benefits, they would fail in such an effort, but that is as it should be from the standpoint of efficiency.

By the same token, were broadcasters afforded (*i.e.*, assigned) the right to be free from such interference, but permitted to sell this right, they would presumably not do so as long as the right to broadcast free of interference were worth more than the value of the interfering use. Note that the resource allocation result is the same, regardless of the rights definition, and turns on the comparative incremental economic values of the “conflicting” activities. All that changes, in consequence of the rights assignment, is who (if anyone) must be induced to forego their right.<sup>16</sup> If broadcasters are awarded the right, they get paid to forego their right if the interfering use is more valuable; if the interfering right is assigned to someone else, they get paid to forego their right if interference-free broadcasting is more valuable.

This reasoning is fine as far as it goes, but it does not go far enough. Leaving aside transactions-costs considerations,<sup>17</sup> the implicit assumption in the foregoing discussion is that the market valuation of broadcasting and any potentially interfering uses reflect their true economic valuations. So the assumption is, for example, that the true economic (marginal) value of, say, a remote control device is approximated by its price—perhaps a not unreasonable assumption in the case of such a device. If the power with which such a device operated had to be reduced to conform to a non-interference requirement and, in consequence, the value of the device were reduced, that reduction would reasonably accurately measure the “social” loss of the reduced utility (*i.e.*, there are likely no “real,” external consequences to be factored in addition).

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<sup>15</sup> The rights definition may well affect the distribution of income, as our illustrative example presently demonstrates. To be sure, changes in the distribution of income undoubtedly matter to individuals, particularly those whose incomes are affected by given actions. The distributional changes may, for this reason, also matter to policy-makers and public officials. Nevertheless, the focus of economic analysis is primarily on efficiency effects.

<sup>16</sup> If the identity of the most valuable use coincides with that of the (initial) rights-holder, no financial transaction is necessary. Where welfare can be improved by a reallocation of conflicting rights, a payment would effect this result.

<sup>17</sup> As noted, we leave aside and avoid discussion of transactions costs considerations not because we do not think they are important—indeed, we think they could often be critical for illuminating assessment of the efficacy of rights allocation by market processes—but because they demand a lengthy analytical treatment and (in our view) externality considerations amply suffice to undercut the case for permitting use of unlicensed devices in the broadcast spectrum without any reference to transactions costs.



Note that this particular assumption is widely granted *not* to be valid in the case of commercial broadcasting—the marketplace value of commercial broadcasting does not accurately or even approximately measure its true economic value. As we have seen, advertisers’ valuations of broadcasting’s productive effectiveness as an advertising medium only very indirectly measure consumers’ valuations of broadcast programming, which tend to dwarf the value of broadcasting in terms of its advertising productivity. This has an extremely important implication for the efficacy of a market-based rights allocation regime.

Even in a perfectly (*i.e.*, frictionlessly) functioning market regime, the existence of important (“real” as opposed to merely “pecuniary”) external economies in commercial broadcasting, which produce quantitatively significant consumer benefits from enjoyment of broadcast programming, imply that commercial broadcasters’ derived demands for “interference protection”—an important productive input for effective service delivery—will substantially understate the value of the marginal *social* productivity of this input. Broadcasters’ derived demand can only be reasonably anticipated to reflect the corresponding input demand (value of marginal product) derived from sales of advertising availabilities.

The social value created by broadcasting self-evidently consists of more than the value it produces in terms of product information, either broadly or narrowly construed.<sup>18</sup> If the FCC were simply to decide whether or how much (or, specifically, where) to allow use of unlicensed devices on the basis of “willingness to pay,” it would likely systematically over-endow such usage. The reason is simple: Consumers’ valuation of a high-quality commercial broadcast service would be virtually unreflected in the amounts “bid.” At the margin, any harm suffered by consumers/viewers would be only very imperfectly embodied in broadcasters’ revealed valuations.<sup>19</sup>

Similarly, *à la* Coase, were such rights simply granted, the value broadcasters might bid to persuade rights-holders to forego or limit such use would be limited to the expected marginal impacts on advertising productivity. Since the “right” (to use unlicensed devices) in this case is to be afforded on a blanket basis, there would be little incentive to act on even this severely circumscribed incentive. Paying people to avoid interfering uses will simply prompt people to line up to receive a payment, but this implies that a “buy-out” strategy is unworkable and will not

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<sup>18</sup> Indeed, the value of the *private* marginal product of advertising to advertisers likely *also* understates its “social” value *qua* advertising, since the widespread availability of product information promotes the effectiveness of competition and thus the overall efficiency with which the enterprise economy functions.

<sup>19</sup> These would be lower to the extent that interfering uses compromised the effective productivity of broadcasting as an advertising medium, but while in the appropriate qualitative direction, would markedly understate the quantitative effects on consumer welfare.

be attempted. Again, the result is too little interference protection from the standpoint of economic efficiency—in particular, from the standpoint of a value calculus that reflects consumers’ valuation of broadcast programming.

**C. TELEVISION BROADCASTING’S “OPEN-ARCHITECTURE”  
MAKES REMEDIAL, VOLUNTARY, MARKET-BASED  
INTERFERENCE SOLUTIONS PROBLEMATIC.**

While ameliorative steps may sometimes be possible to mitigate the harmful effects of new sources of interference, the “open architecture” characteristic of broadcasting<sup>20</sup> makes it difficult for broadcasters, acting on their own initiative, to take effectively remedial steps to cope with interference from other sources. Any attempt to condition the broadcast system against new forms of interference may be undermined and produce less than the maximum effect to the extent that it depends on cooperation from the producers of *other* inputs (in particular, the producers of television sets) to the production process. The latter may fail to implement complementary economic remedial actions or may even behave opportunistically—viewing remedial efforts by others as an opportunity simply to reduce their own efforts. Such actions may be entirely economically rational and completely consistent with profit maximization.<sup>21</sup>

The mere existence of potential remedial actions is of virtually no import in the absence of effective economic incentives for adoption of such actions on an efficient basis. In broadcasting, the existence of an open architecture, while offering benefits along other dimensions, operates against ameliorative steps being successfully undertaken to deal with new sources of interference produced by widespread use of unlicensed devices.<sup>22</sup>

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<sup>20</sup> In this context, “open architecture” refers to the lack of control that broadcasters have over the manufacture and sale of the devices, i.e., the TV sets that receive the broadcasters’ signals. Unlike subscription video services, for which the suppliers have design control over consumer set top boxes that are used on cable or satellite systems, free over-the-air television stations are unable to control the design of receiving devices. On the contrary, the technical standards that have been adopted by the appropriate standard setting organization, e.g., ATSC, and approved by the Commission, are inherently open and cannot unilaterally be restricted by broadcasters. In particular, no individual broadcaster or group of broadcasters can unilaterally effectuate changes to receiving devices to provide greater interference protection from unlicensed devices.

<sup>21</sup> There may, nevertheless, be less costly means of interference amelioration that could be implemented by set manufacturers that would increase overall economic efficiency, but will not be implemented in the absence of effective means to capitalize on (profit from) such actions “to internalize externalities.”

<sup>22</sup> The broadcasting system’s open architecture renders it difficult for broadcasters, acting individually or, even more unrealistically, collectively, to (compel manufacturers to) condition receivers against interfering uses, in particular, use of unlicensed devices. It may well often be the case that adapting receiver technology is the easiest and most effective way to cope with interfering emissions. As we presently note in the text, the avenues available to  
*(footnote continued)*

Another potential problem with television broadcasting's "open architecture" concerns the lack of consumer feedback and the inability to police interference. Throughout its history, the FCC has had a difficult time policing sporadic interference on the television band. When confronted with such interference, consumers rarely contact local stations, consumer electronics manufacturers or the FCC. Rather viewers tend to simply switch channels to other services or channels. As a result, it becomes difficult—if not impossible—to take corrective action. As we will discuss, *infra*, consumer reaction to interference may have a significant impact on the DTV transition.

The current industrial structure may exacerbate the problems of ameliorating interference. Manufacturers will produce DTV sets not only to receive broadcast signals, but also for cable and satellite reception and to play DVDs. If insulating television sets from interference from unlicensed devices turns out to be expensive, the set manufacturers may well choose not to incur the costs. Even though the sets might be less than fully satisfactory for broadcast reception, they could still (fully) meet the needs of cable, satellite and DVD viewers. This course of action may be completely logical, from the perspective of the set manufacturers, but it would have perverse competitive implications, as discussed *infra*.<sup>23</sup>

There may well exist other spectrum operating environments where the industrial organization is such as to permit greater coordination and control of interference-ameliorating steps. For example, partial or full integration of disparate activities reduces the need for inter-firm coordination and may help achieve more efficient outcomes in some operating venues. In reality, however, the existence of an open architecture in broadcasting mitigates against such coordination and effective internalization, limiting the scope for amelioration of interfering usage.

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broadcasters to take remedial steps and for which there exist sufficient incentive to pursue such actions, may be severely limited. Moreover, it may be impossible for broadcasters to diagnose problems "caused" by use of unlicensed devices and to identify efficient solutions.

<sup>23</sup> We recognize that the Commission has commenced a proceeding examining the use of "performance specifications" to address the problems of interference emanating from unlicensed devices. See *Notice of Inquiry, Interference Immunity Performance Specifications for Radio Receivers*, ET Docket No 03-65, MM Docket No. 00-39 (released March 24, 2003.) It remains to be seen whether the proposals outlined in the proceeding, especially those calling for "voluntary specifications," will be sufficient to internalize costs and address broadcastings the unique problems. The analysis presented above demonstrates that there are significant obstacles to unilateral, voluntary corrective measures that may be taken by individual industry participants.

#### **D. “SMALL” BROADCAST SERVICE DEGRADATIONS CAN PRODUCE LARGE ADVERSE ECONOMIC CONSEQUENCES**

Wherever the use of unlicensed devices produces interference sufficient to degrade a broadcaster’s ability to deliver audience exposures of a specific number and quality and/or consumers’ ability to receive desired programming,<sup>24</sup> adverse economic consequences will result: The price of a broadcaster’s commercial minutes would presumably fall to reflect the reduced audience size/effectiveness of delivery. Consumers’ valuation of broadcast programming would also fall reflecting the reduced quantity and quality of broadcast programs.<sup>25</sup> Both advertisers and consumers would thus suffer some form of economic harm. The amount of the harm suffered would, of course, depend on the magnitude of the service corruptions produced by specific types and amounts of interfering usage.

Interference effects might conceivably be sporadic, leading to losses of service for short durations. And this, in turn, might portend relatively small sacrifices in the quality (and *expected* value) of the commercial exposures offered to advertising customers or the programming reception quality offered to consumers. Nevertheless, because the size of the relevant economic markets (*viz.*, for both commercial exposures and in terms of the value derived by very large numbers of consumers from broadcast programming) is so large, even small interference-derived service degradations could quite conceivably produce economically significant adverse consequences.<sup>26</sup>

There are two distinct problems that will occur during the transition. First, there are over 267 million analog television sets in consumer’s homes today. The design specifications of these

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<sup>24</sup> Our understanding is that the contemplated authorization would be for use of unlicensed devices as “overlay” services occupying current “vacancies” in the broadcast spectrum. There would thus appear to be some significant potential for signal interference where devices erroneously transmit in occupied “spaces”—*i.e.*, where “out-of-bounds” emissions along any of a variety of possible dimensions exceed the “interference temperature” (the FCC Spectrum Task Force’s useful “umbrella” rubric that remains largely unspecified and non-operational) deemed economically optimal for protecting the reception fidelity of broadcast transmissions.

<sup>25</sup> If there were an interruption of service at a critical moment, say at the end of a fiercely contested athletic contest or the climax of a story, the small loss in “quantitative” terms might greatly understate the qualitative loss to viewers.

<sup>26</sup> *Cf.*, by way of analogy, that the FTC once alleged that the exercise of a “shared monopoly” in the “ready-to-eat” cereals industry, while raising the price by only a small number of mills per serving, resulted in aggregate losses in the hundreds of millions of dollars given the total number of servings (bowls) of cereal consumed on a daily basis. Small losses per individual unit can translate into substantial losses in aggregate when, as in the instant setting, large numbers of units are implicated (*viz.*, significant numbers of viewers suffer a service degradation that also translates into significant degradation in the quality of particular commercial minutes in terms of the quality of the audience exposures effectively delivered).

receivers did not anticipate shielding them from a plethora of unlicensed devices that may occupy the television band.

The second, and perhaps more troubling, scenario involves new DTV receivers. In the DTV environment, interference can cause a complete loss of service to the affected consumer(s). This happens whenever the unlicensed device gets sufficiently close, or the number of unlicensed devices accumulates to the extent, that they effectively “overload” the television receiver. Television receivers will be especially susceptible to such overloading in areas where the broadcast stations signal strength is weaker. Problems may occur with indoor reception throughout a market, where walls attenuate an otherwise strong broadcast signal. Similar concerns may also arise in rural areas located at the edge of a broadcast stations market. In these areas, signal strength is weak, and receivers are more susceptible to overloading from other devices occupying television bands.

A “small” harm suffered by a large number of people or inflicted on a large number of units of output may still amount to a substantial harm. Minimal service interruptions or degradations in reception fidelity suffered by enough viewers may constitute a significant harm, even though the harms suffered on an individual basis may suffice to produce nary a complaint by any single individual (consumer or advertiser).

In this case, there is a clear danger of “death by a thousand cuts” unless care is taken to “count” harms properly in the aggregate. Individual consumers may lack the economic incentive to complain, given their small individual “stake” (in the form of annoyance, loss of product effectiveness, loss of sales, *etc.*), but the *aggregate* adverse impacts may more than suffice to warrant intervention to prevent the resultant aggregate harms. As discussed below, this could have a dramatic impact on the DTV transition.

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### III. DERAILING THE DIGITAL TRANSITION BANDWAGON

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In addition to the risks identified above, the contemplated unlicensed use of television channels also threatens to undermine the transition to digital television. We have written extensively about the supply and demand factors that make for a successful economic “bandwagon” product.<sup>27</sup> Bandwagon effects are a type of economic consumption externality. Of particular

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<sup>27</sup> One of us (Rohlf) is the author of a leading economic treatise on *Bandwagon Effects in High Technology Industries* (MIT Press, 2002); and we are the joint authors of *Propelling the Broadband Bandwagon: And Now...But First*, (September 2002), prepared for the United Kingdom’s Office of Telecommunications (OFTEL). See <http://www.oftel.gov.uk/publications/broadband/other/spr0802.pdf>. We have, in addition, commented on several occasions in Commission proceedings specifically addressing policy issues implicated in the digital *(footnote continued)*

interest for analysis of the transition to digital broadcast television are so-called “complementary bandwagon effects” that derive from increased supplies of *complementary products* as the user set (*viz.*, the number of digital broadcast viewers) expands. In the case of digital television broadcasting, digital broadcast transmission and reception capabilities and related programming inputs can all be viewed as economically complementary to one another in the analytically relevant “bandwagon-effect” sense.

Complementary bandwagon effects occur because the benefit of one product depends at least partially on the supply of complementary products. Thus, complementary bandwagon effects derived from increased supplies of digital broadcast transmissions and programming may occur as consumer take-up increases: More viewers make development of more programming material and increased investment in greater transmission capabilities more attractive, which in turn potentially leads to “positive feedback” and increases the number of viewers, setting the stage for a continuation of the cycle. In economic terms, a “bandwagon gets rolling” when “critical mass” is achieved and positive feedback occurs *spontaneously*: more viewers produce more broadcasts and programming, producing more viewers and so on in an upward spiral.

Products and services subject to complementary bandwagon effects are often subject to so-called “chicken-and-egg” problems. Rohlfs defines the generic problem in the following terms:<sup>28</sup>

The base product (the ‘chicken’) may have no value apart from the supply of complementary products (the ‘egg’). The complementary products, in turn may have no value without the base product. The problem is that the suppliers of the base product may not supply it unless the complementary products are already available. Suppliers of the complementary products may not supply them unless the base product is already available. Without coordination of the suppliers of base products and complementary products, there may be no way for *either* the chicken or the egg to come first.

Government policies can conceivably help *or hurt* when it comes to “solving the start-up problem” for a bandwagon product like digital broadcast television, and enabling it to reach its full potential and maximize economic benefits. The essence of the problem is how to reach critical mass, assuming there is a critical mass at which the growth of digital broadcasting can

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transition. See, e.g., John Haring, *The Economic Case for Digital Carriage Requirements*, prepared for Association of Local Television Stations, CS Docket No. 98-120, *In the Matter of Carriage of the Transmission of Digital Broadcast Stations* (October 13, 1998).

<sup>28</sup> See Rohlfs, *op. cit.*, at 235.

become self-sustaining. The latter is, by no means, a foregone conclusion: given its costs, only a limited set of viewers might find the service sufficiently attractive to acquire. The limited size of the audience may permit economic development of only a limited number of outlets and suitable programming—end of story.

Alternatively, perhaps at some point the value-for-money proposition can become sufficiently favorable to attract a sufficiently large audience to spontaneously induce additional investments in complementary inputs that, in turn, attract more viewers, inducing more investment, in an ascending spiral of positive feedback that ends in virtual universality (as have previous broadcast innovations—*cf.* television, color TV, *etc.*). The specific identity or even the existence of that critical level is unknown and, indeed, probably unknowable in advance. So the policy target amounts to *affording the best chance for realization of critical mass*, presuming it exists, *consistent with an economically rational promotional strategy (i.e., one based on prudent assessment of incremental costs and benefits of different policy tacks).*

This is the policy context in which the Commission's contemplation of an authorization of use of unlicensed devices in the broadcast spectrum occurs and needs to be considered. If such an authorization makes no difference, these issues are moot. But if it makes a difference, in particular, if it potentially disables the new service—perhaps even only on a sporadic basis—this will inhibit the new service's ability to achieve critical mass, spontaneous feedback and service takeoff.

In this regard, we note that the significance of even infrequent interruptions at this early stage of the product cycle may have disproportionate negative effects on demand. Because consumers will initially have had little experience with off-air DTV, problems with off-air reception may affect their entire perception of the product and discourage widespread adoption.

As the Commission is amply aware, a lot is riding on a successful transition to digital television broadcasting. The advent of digital broadcast television is potentially a highly significant change that promises to accelerate the ongoing convergence among telecommunications, computing, the electronic mass media, the Internet and, significantly, the world of commerce. The new technology affords broadcasting an entrée into and technical means that are, in principle, compatible with the Information Age revolution that is rapidly remaking how we live and work. Collectively, broadcasters are betting billions of dollars on a digital future, but success is far from assured.

Among the important public policy goals at stake are the successful introduction of digital broadcast television and the subsequent recovery of the vacated broadcast spectrum and retention of the strength and competitiveness of broadcast television—the latter now more than ever an important objective given the unregulated monopoly power of the cable industry.

Commission policies can specifically undercut achievement of critical mass for digital television broadcasting in the following manner: Suppose sporadic reception failures are produced by use

of unlicensed devices with the result that, at the margin, fewer viewers choose to view digital television over-the-air. That would potentially produce a variety of *adverse* (as opposed to positive) feedback effects.

We could envision several interrelated economic developments. Finding reception problems with new off-air DTV sets, early adopters may decide to avoid off-air DTV programming altogether, preferring instead to consume high quality DTV pictures through DVDs, cable or satellite offerings. This outcome may have an adverse impact on the demand for off-air digital receivers by consumers as the technology diffuses through the general population.

Smaller potential audiences obviously make investments in program and transmission equipment upgrades less attractive. Lower sales of digital sets and tuners slow the pace at which suppliers of such equipment “move down the learning curve” and the ease with which they can realize economies of larger scale production. Bandwagon effects may operate, but the bandwagon may roll *in the wrong direction*.

This outcome would also have serious negative implications for competition. Broadcast-originated DTV, with the combination of multicasting and HDTV, has the potential to become a stronger competitor to cable in the future. The good news is that this alternative will get much better as broadcast DTV evolves (though competition for the digital viewer is in its infancy). The bad news is that this intensifying of competition may never be realized if the transmission path of digital broadcasting to the home becomes impaired due to interference from unlicensed devices.

A satisfactory DTV alternative to cable would benefit *all* viewers—not just those who watch television over the air. Such an alternative would discipline the cable rates that the Commission has despaired of regulating. As a result, multichannel viewers would pay significantly less for service—so long as the DTV bandwagon is not derailed.

With so much riding on a successful transition (realization of a digital future and all the good things directly attendant upon that, the freeing-up of valuable analog spectrum space for repacking, the revitalization of broadcasting as a competitive constraint on the cable monopoly, the macro benefits to the economy stemming from the opening up of an exciting new set of production opportunities), the cost of “missteps” loom significantly. At the same time, as we will discuss *infra*, the benefits to be produced by authorization of potentially interfering uses of unlicensed equipment are largely speculative.



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#### IV. BENEFITS OF PERMITTING UNLICENSED DEVICES IN THE TELEVISION BROADCAST SPECTRUM

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The economic benefits derived from commercial broadcasting, while difficult to measure because the most quantitatively significant transactions occur in a “barter” market where consumers “pay” attention for programming, are large in magnitude and their specific identity is known. In contrast, the benefits potentially to be derived from use of unlicensed devices, in many cases yet to be invented, are uncertain and their specific identity is largely *unknown*. In touting the potential for invention of valuable new applications, the Commission has pointed to past experience,<sup>29</sup> but the inferences appropriately drawn from the recent historical record are, for a variety of good reasons, ambiguous.

##### A. THE BENEFITS ARE LIMITED BY THE LAW OF DIMINISHING RETURNS.

The economic law of diminishing returns describes the direction and rate of change output takes when the input of a specific resource (*viz.*, in this case, spectrum operating rights) is varied with inputs of other resources held constant.<sup>30</sup> It states that total output will increase with increases in the input of the specific resource, but beyond some point the resulting output increases will become smaller and smaller (and perhaps eventually negative).

In the instant setting, the law of diminishing returns implies that while increases in the amount of spectrum inputs available for use for unlicensed devices might yield output increases, the resultant increases in output will be *smaller* than that initially produced by more limited use of spectrum inputs. Operation of the law of diminishing returns thus suggests that the immediate past may produce an overly rosy picture of the magnitude of output increases reasonably to be anticipated from application of additional spectrum inputs for use with (*existing*) unlicensed device technology.

As time passes, quantities of other inputs, notably ideas for new applications, may also be increased (*i.e.*, inputs of other resources may not be “held constant”). But the farther in the future these are assumed to occur, the greater the applicable (time-) discount factor that needs to be applied to estimate the *present* economic value of future outputs. In the near term, the

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<sup>29</sup> See *NOI*, § III.

<sup>30</sup> See, e.g., Richard H. Leftwich, *The Price System and Resource Allocation* (Holt, 1966), at 99-100. Professor Leftwich observes that “The law is consistent with observations that there are limits to the output that can be obtained by increasing the quantity of a single resource applied to constant quantities of other resources.”

marginal efficiency of capital (in the instant setting, *intellectual* capital, viz., design concepts for new applications) is generally regarded as fixed, implying declines in expected payoffs from undertaking additional projects utilizing additional spectrum inputs. This suggests that simple extrapolation of past experience with unlicensed devices to fathom the future will likely produce unrealistically optimistic expectations and projections about future prospects.

#### **B. DOWNWARD SLOPING DEMAND CURVES LIMIT THE BENEFITS.**

In addition, because demand curves are downward sloping, the *value* of additional output of a given type generally declines with increases in (inputs and) output. Thus, the incremental value of increases in outputs of currently produced products utilizing unlicensed devices will generally be lower, other factors the same. This is another factor suggesting that the value of incremental output will be lower than that initially produced in the past.

#### **C. UNCERTAIN SPECTRUM AVAILABILITY DURING THE TRANSITION LIMITS THE BENEFITS.**

There is a serious question regarding whether “shared” television spectrum offers a sufficiently predictable source of spectrum for many potential applications. At the present time, spectrum use by television stations may be operating at maximum capacity.<sup>31</sup> The creation of DTV has effectively doubled the number of television stations operating in the television band (channels 2 through 69). Moreover, for the remainder of the DTV transition, channel use will be fluid. For example, both analog and digital television stations must vacate channels 52 through 69, and relocate on channels 2 through 51. By statute, the FCC must find 175 additional television broadcast channels. Stations must determine their final channel for digital operations. There are additional issues regarding maximization of station power, replication of service area, and the status of Class A low-power stations. Significant uncertainty will remain until the broadcast spectrum is completely repacked.

Such uncertainty limits the value of new “unlicensed uses” in shared broadcast spectrum. For example, depending on the device, firms would often focus their marketing efforts in the larger urban markets. However, it is in these markets where spectrum use is most congested. Adding to this problem is the potential for numerous channel changes as stations select their final DTV channels. The ability of a device to find “vacant” spectrum in congested and constantly

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<sup>31</sup> The FCC’s proposal for unlicensed devices assumes there is a time diversity component to spectrum use. In other words, “smart” devices will be able to use spectrum in an intermittent basis. As we previously observed, however, the average television set operates nearly 8 hours per day and most stations broadcast 24 hours per day. The potential for intermittent re-use of a broadcast channel is, therefore, limited.

changing channel-use environment may be problematic.<sup>32</sup> Accordingly, the presumed consumer welfare and societal benefits from unlicensed devices may be severely limited where demand would otherwise be the greatest. The most stable spectrum environment for such devices may be in some rural areas, where there is available spectrum, but demand may be much lower.

#### **D. BENEFITS ARE LIMITED BY THE HIGH COST OF AMELIORATING INTERFERENCE.**

Technical engineering considerations are also relevant for a realistic assessment of prospects for successful development of valuable new economic applications. If demanding non-interference requirements are imposed on the operation of unlicensed devices in the broadcast spectrum—to avoid corruption of a highly valued, highly “visible” service—the developer of a new application will have to engineer around the constraints imposed by stringent non-interference requirements. That may be possible, but necessarily entails higher costs. Indeed, the costs may be so high as to preclude profitable production of the devices.<sup>33</sup> This consideration further limits the value of permitting unlicensed use of the spectrum.

#### **E. BOTTOM LINE.**

The specific identity of new unlicensed devices is largely unknown and the value of their prospective benefits is largely speculative. There are a variety of economic, policy and technical factors suggesting that the prospects for successful introduction of valuable new applications involving the use of unlicensed devices in the broadcast spectrum may be limited. These include the operation of the economic law of diminishing returns, which implies that, until new applications are developed, incremental outputs from increased use of spectrum inputs are likely to be smaller and smaller. Combined with operation of the economic law of demand, which implies that the *value* of incremental outputs will also be smaller, there are thus good economic reasons to question the Commission’s central premise that large benefits are in immediate prospect. Uncertainty regarding spectrum availability, especially in urban markets, is a further limiting factor. Finally, economic prospects for successful innovation would be further limited by the high costs that would likely need to be incurred to engineer new services to operate successfully, consistent with meeting demanding non-interference requirements.

The Commission’s *NOI* poses an economic tradeoff (at the margin) between known goods and services, very highly valued by the consumers and producers who utilize them, and a new

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<sup>32</sup> Indeed, a number of proprietors of innovative spectrum-using devices have requested their “own” spectrum, which would provide certainty with respect to spectrum availability.

<sup>33</sup> See Stuart Lipoff, “Exploring the Feasibility of Spectrum Sharing of the TV Band with Unlicensed Devices,” April 2003.

speculative set of goods and services, whose specific identity is unknown and regarding whose economic value and successful realization there are good economic and technical reasons for at least some skepticism. In our view, these are not especially attractive “terms of trade.”

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## V. PERMITTING UNLICENSED DEVICES ON BROADCAST SPECTRUM WILL HAVE NEGATIVE, LONG-TERM IMPLICATIONS FOR SPECTRUM USE AND VALUE

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The FCC’s proposed unlicensed device policy may have long-term ramifications on the value of spectrum. Authorization of unlicensed device use presumably requires, in the first instance, identification of an “interference temperature” at which operation of such devices will not impose costs/adverse consequences in terms of harms to broadcasting in excess of any putative benefits anticipated.<sup>34</sup> But this raises a thorny issue: There is no guarantee or reasonable expectation (or even basis for formation of a “reasonable” expectation) about the optimality of this temperature limit in terms of potential *future uses*.

The temperature requirements adopted might represent a significant *encumbrance on future uses* of this spectrum space. There is no necessary connection between present optimality and future optimality of a particular interference temperature setting. In effect, the Commission would be creating a class of “squatters,” thereby preventing future, and perhaps more beneficial uses, for reclaimed broadcast spectrum.<sup>35</sup> Moreover, the presence of these devices on “in-core” broadcast channels may preclude future advancement to the television broadcast system. For example in another proceeding the FCC has proposed permitting lower power “distributive” transmitting technology in the broadcast band. The success of such endeavors may well depend on the availability of spectrum that is free and clear of other interfering devices.

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<sup>34</sup> As we earlier noted, one problem with assessing the relevant cost/benefit calculus is that costs of potentially foregone broadcast benefits are inherently hard to measure because broadcast programming is exchanged in a “barter” transaction with viewers, who pay “attention” which is then repackaged for sale to someone else for a different purpose.

<sup>35</sup> The Commission could conceivably try to limit the “lifetime” of the relevant authorization of unlicensed device usage. Enforcement of such a policy would, however, be exceedingly difficult. In particular, many small users would likely try to continue (and believe they had the right to continue) using devices that they bought many years in the past. Such a policy, if it were feasible (and it probably would not be politically feasible) would limit the benefits of unlicensed devices by “closing the window” for successful exploitation of such devices.

Finally, to the extent the FCC views reclaimed broadcast spectrum as a potential revenue source, the authorization of unlicensed devices has a predictable consequence on the amounts likely to be bid at auction for any reclaimed broadcast spectrum. *It reduces their expected magnitude.*

So an additional adverse consequence to be weighed against any putative benefits is the inability to employ new uses for spectrum and the potential for reduced revenues as operating rights are repackaged and auctioned (as well as reductions in the value consumers derive from services produced from the repacked spectrum). Note, again, that with an authorization of unlicensed use, there is little prospect for “buyouts” that correct impediments to new developments. People would “line up” to receive payments, rendering this tactic non-viable.

**Bottom Line:** There are already a substantial number of “balls in the air” in the complex context of the ongoing transition to digital television broadcasting: the need for huge investments in new technological gear and components, development of additional program resources, consumer education and the timeframe for spectrum repacking and realization of budget revenues by the government from auction of vacated spectrum properties. In our view, the idea that what we now need is still *another ball* is far from obvious.

Perhaps another ball would be worthwhile if expected benefits were great and the prospect for adverse impacts nil. But there is little evidentiary basis to anticipate large payoffs in the near term. At the same time, the digital broadcast bandwagon must reach critical mass to get rolling. Authorizing use of unlicensed devices in the broadcast spectrum at this time would make it more difficult to achieve critical mass by inhibiting the pace of consumer take-ups. In our view, the appropriate goal of policy should be to “smooth the bandwagon’s glide path,” not to erect roadblocks and scatter rocks that deter needed investments and stifle positive feedback effects from materializing.

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## VI. CONCLUSION

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Authorization of the use of unlicensed devices in the broadcast band at this time would take what is already an exceedingly complex industrial transition process and turn it into an even more complicated process, with significant potential for highly costly, adverse consequences in terms of the defined goals of policy. In our view, it would be questionable whether the risks entailed would be worth incurring, even were the benefits presumed to be great, a presumption for which there is little evidentiary basis and some basis for questioning. At the same time, the risks of harm are substantial, given the huge stakes in the success of the transition to digital broadcast television, including the value of digital service itself, the value of eventually repackaged spectrum resource rights at auction and the value of digital broadcasting as a competitive check on the cable industry’s monopoly power.

Our conclusion is that this inquiry proposes a trade whose terms entail risking a lot for a little and, as such, one that should be rejected as imprudent.

There is one last point we would like to make about the strategy of reform in the spectrum resource rights regime. Reforms can be substantially undermined by missteps that give reforms a black eye. This is an argument for proceeding carefully and choosing the most promising areas for reform in initial forays. In our view, the instant proceeding does just the opposite: It selects a target where risks of harm are significant, highly visible and the benefits are largely speculative. At the same time, because of externalities (as discussed *supra*), market processes are significantly impaired in their ability to promote economic efficiency. This item does not represent “forward progress” in terms of regime reform.